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ICHKI YONUV DVIGATELINING ISH REJIMINI TANLASH VA GIBRID DVIGATELNI BOSHQARISH ALGORITMINI ISHLAB CHIQISH

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Annotatsiya. *Maqolada ichki yonuv dvigatelining ish rejimini tanlash va gibrid dvigatelni boshqarish algoritmini ishlab chiqish masalasi ko'rib chiqilgan. Bunda elektr yuritmaning ishlash shartlari, rekuperativ tormozlanish shartlari hamda avtomashina harakati uchun boshqa zaruriy shartlar o'rganib chiqilgan.*
Kalit so'zlar: *boshqaruv rejimlari, rekuperatsiya, elektr dvigatel, gibrid yuritma, harakat sikllari, burovchi moment.*

ВЫБОР РЕЖИМА РАБОТЫ ДВИГАТЕЛЯ ВНУТРЕННЕГО СГОРАНИЯ И РАЗРАБОТКА АЛГОРИТМА УПРАВЛЕНИЯ ГИБРИДНЫМ ДВИГАТЕЛЕМ

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Аннотация. *В статье рассматривается вопрос выбора режима работы двигателя внутреннего сгорания и разработки алгоритма управления гибридным приводом. Изучены условия работы электропривода, условия рекуперативного торможения и другие необходимые условия движения автомобиля.*
Ключевые слова: *режимы управления, рекуперация, электродвигатель, гибридный привод, циклы движения, крутящий момент.*

SELECTION OF INTERNAL COMBUSTION ENGINE OPERATING MODE AND DEVELOPMENT OF A HYBRID ENGINE CONTROL ALGORITHM

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Abstract. *The article discusses the issue of choosing the operating mode of an internal combustion engine and developing a control algorithm for a hybrid drive. The operating conditions of the electric drive, the conditions of regenerative braking and other necessary conditions for vehicle movement were studied.*
Keywords: *control modes, recuperation, electric motor, hybrid drive, driving cycles*

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Kirish. Optimallashtirish usullariga asoslangan boshqaruv rejimlaridan foydalanish ularning avtomobilning gibrid haydovchisi parametrlarini tanlashga ta'sirini bartaraf etishga imkon beradi. Gibrid yuritmaning asosiy parametrlari quyidagilar: ichki yonuv dvigatelining maksimal quvvati va elektr transport vositasi, shuningdek, tortish batareyasining quvvati [1-3].

T_{IYoD} – IYoD burovchi momenti, Nm

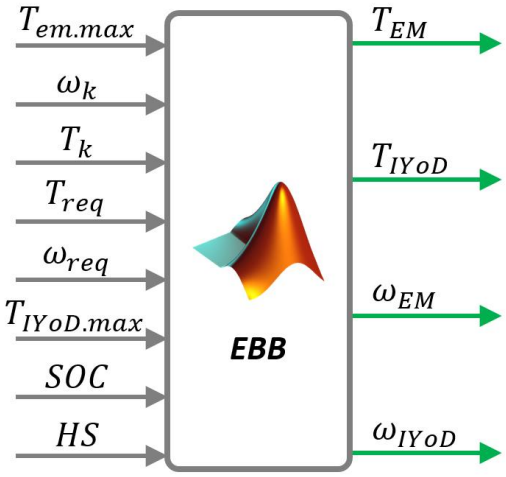
ω_{EM} – elektr mashinasi burovchi momenti, Nm

ω_{IYoD} – IYoD burovchi momenti, Nm

SOC – Batareyaning zaryadlanganlik darajasi, %

Harakat turini tanlash.

Harakat turini tanlash, ya'ni shahar (***HS=1***) yoki magistral (***HS=2***) harakat turlaridan birini tanlash orqali amalga



1-rasm. Elektron boshqaruv blokiga kiruvchi kattaliklar va chiquvchi kattaliklar

Adabiyot tahlili va usullari. Muayyan haydash sharoitida eng kam yoqilg'i sarfiga erishish uchun gibrid avtomobil parametrlarini aniqlash uchun ushbu parametrlarning avtomobilning yoqilg'i sarfiga ta'sirini tahlil qilish kerak. Ushbu parametrlarni o'zgartirib, barcha dinamik talablarga javob beradigan va ayni paytda eng kam yoqilg'i sarfiga ega bo'lgan parametrlar kombinatsiyasini topish mumkin [4-7].

Rekuperative+friksion tormozlash

T_k – g 'ildirakdagi burovchi moment, Nm

T_{req} – uzatmalar qutisi kiruvchi valida talab qilingan burovchi moment, Nm

T_{EM} – elektr mashinasi burovchi momenti, Nm

oshiriladi. Amaliy holatda bu jarayon haydovchi tomonidan kerakli tugmani bosish orqali tanlanishi mumkin. Bunda avtomobil shaharda hrakatlanganida asosan elektr yuritmasidan foydalanadish nazarda tutilgan. Magistral siklda tortish rejimi ichki yonuv dvigateli tomonidan amalga oshiriladi.

Harakat rejimini tanlash

Harakat rejimlarini tanlash, talab etilgan burovchi moment T_{req} qiymatiga bog'liq holda aniqlanadi. Bunda $T_{req} > 0$ tortish rejimini anglatadi va tortish uchun zarur bo'lgan energiya manbai tanlanilishi lozim. $T_{req} = 0$ to'xtab turish rejimini ifodalaydi. Tormoz rejimida bu burovchi moment manfiy qiymatga ega bo'ladi, ya'ni

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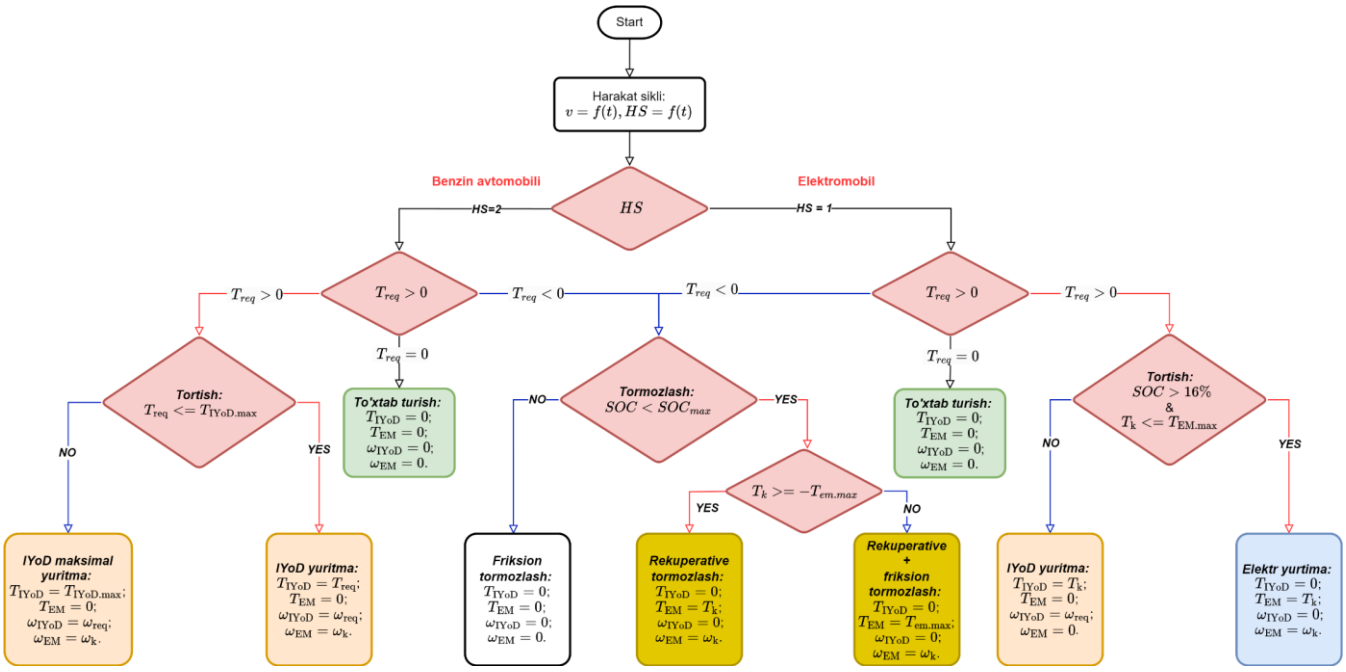
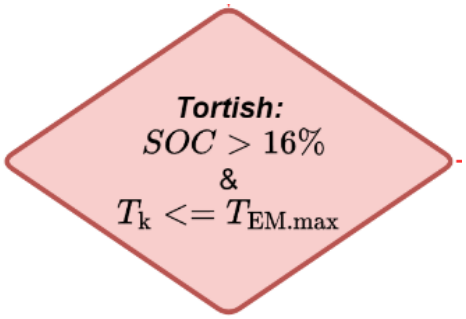


$T_{req} < 0$.

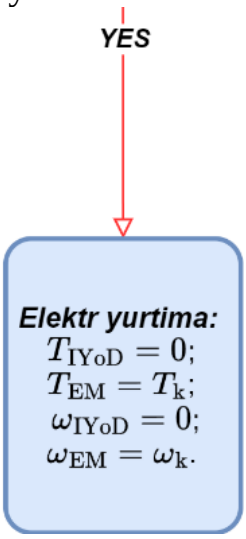
Elektr yuritma

Haydovchi tomonidan ***HS=1*** (shahar) rejimi tanlanganda belgilangan algoritmga ko‘ra elektr yuritmada harakatlanish ta’minlanadi. Bunda bir qancha shartlar bir vaqtning o‘zida bajarilishi talab etiladi. Kiritilgan shartlar barchasi to‘liq bajarilmagan holatda, avtomashina avtomatik ravishda ***HS=2*** (magistral) rejimga o‘tadi. Elektri yuritmada harakatlanish uchun:



1) *SOC>16%* sharti, ya’ni elektr batareyaning zaryadlanganlik darajasi belgilangan miqdordan (masalan, 16%) yuqori bo‘lishi;

2) $T_k <= T_{EMmax}$, ya’ni T_k g‘ildirak burovchi momenti elektr yuritma burovchi momentiga teng yoki kichik bo‘lishi shart.



Yuqoridagi ikki shart bajarilgan taqdirdagina avtomashina elektr yuritmada harakatlanadi. Agar shartlardan biri bajarilmay qolsa, ichki yonuv dvigatelida harakatlanadi.

To‘xtab turish

Harakat rejimlaridan biri tanlanganda $T_{req}=0$ bo‘lgan holatda, to‘xtab turish amalga oshiriladi. Bunda ichki yonuv

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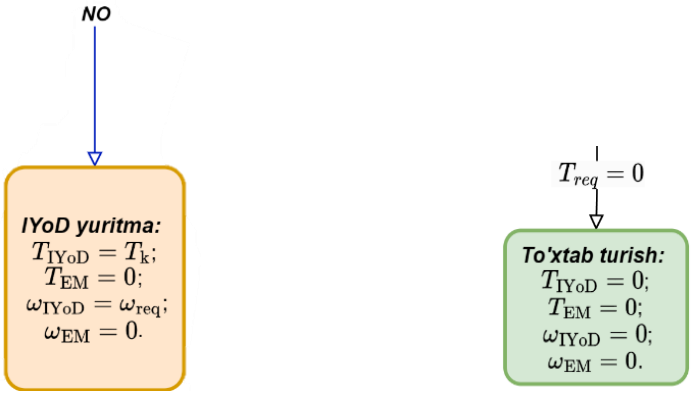


a) *b)*

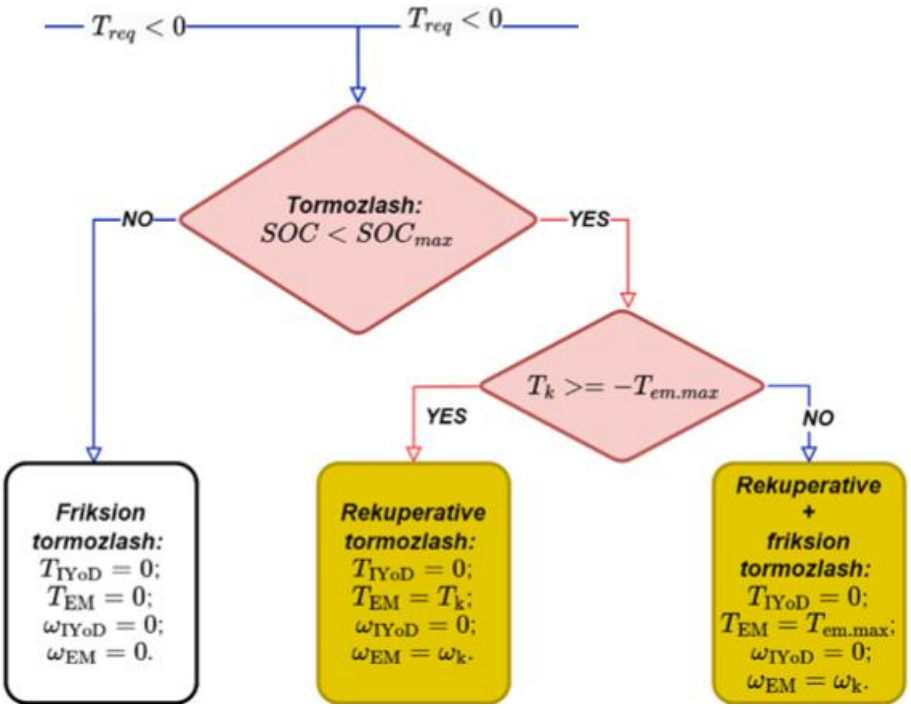
2-rasm. Harakat rejimlarining shartlari

dvigatelining va elektr dvigatelning burovchi momenti 0 ga teng bo‘ladi va o‘z-o‘zidan dvigatellarning aylanma tezligi (ω_{EM} va ω_{IYoD}) 0 qiymatga ega (Rasm 2. *b*).

Tormozlash

Harakat rejimlari tanlanganidan so‘ng $T_{req}<0$ bo‘lsa, ya’ni burovchi moment manfiy qiymatda bo‘lganda, tormozlanish amalga oshiriladi. Bunda tormozlash jarayonining bir qancha shartlariga ko‘ra *rekuperativ*, *friksion* yoki *rekuperativ* + *friksion* tormozlash rejimi ishlashi mumkin.

$SOC<SOC_{max}$ sharti bajarilganda, ya’ni, batareyaning zaryadlanganlik darajasi, belgilangan miqdordan kichik bo‘lgan holatda, *rekuperativ* tormozlanish ishlaydi.



3-rasm. Tormozlash shartlari

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Yuqoridagi shart bajarilmaganda, *friksion* tormozlanish amalga oshiriladi. $T_k >= -T_{em.max}$ holatida, g‘ildirakdagi tormozlovchi moment elektr dvigatel maksimal burovchi momentidan katta yoki teng bo‘lganda, *to‘liq rekuperativ* tormozlanish ishlaydi. Mazkur shart bajarilmaganda esa, *rekuperativ + friksion* tormozlanish amalga oshiriladi.

Ichki yonuv dvigateli

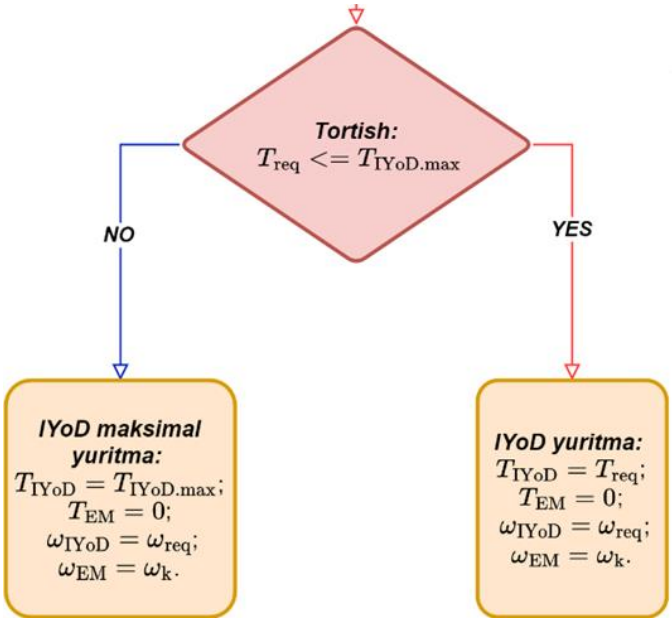
Harakat rejimlaridan ***HS=2*** tanlanganda, ya’ni magistral harakat rejimida belgilangan shartlar bajarilsa, ichki yonuv dvigateli avtomashinani harakatlantiradi.

Ichki yonuv dvigateli

$T_{req} =< T_{IYoD}$ sharti ichki yonuv dvigatelining magistral harakat rejimida ishlashini ta’minlaydi. Bunda yuqoridagi shart bajarilsa, ichki yonuv dvigateli tomonidan talab etilgan burovchi moment yetkazib beriladi, ya’ni

$T_{IYoD} = T_{req}$; $T_{EM} = 0$; $\omega_{IYoD} = \omega_{req}$; $\omega_{EM} = \omega_k$

Agar yuqoridagi shart bajarilmasa (No), ya’ni talab etilgan burovchi moment ichki yonuv dvigatelining maksimal yetkazib beradigan burovchi momentidan katta bo‘lsa, ichki yonuv dvigateli o‘z imkoniyatidagi burovchi momentni yetkazadi Bunday shart kiritilishidan maqsad gibrid yuritmani harakat shartlarini belgilashda magistral rejim tanlanib, talab etilgan burovchi moment ichki yonuv dvigatelining burovchi momentidan katta bo‘lgan hollarda, qo‘shimcha ravishda elektr motorni ishga tushirmaslikni ifodalash uchun kiritilgan.



Xulosa. Tanlangan gibrid rejim tyuningli bo’lganligi sababli murakkab gibrid boshqaruv rejimlari inobatga olinmagan.

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